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Application and Use of Forestry Economics by the Forest Service, U.S. Dep't. of Agriculture

Report of a Sabbatical Study
for
Policy Analysis Staff
Forest Service
U. S. Department of Agriculture

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EXECUTIVE SUMMARY

The Forest Service faces an extremely diverse set of natural resources, an unbelievably complex set of public pressures, and great uncertainty about the future, from budgets to biological events. Within this milieu, the Agency manages the largest concentration of public land in the country. Central to acheiving the balancing act required in this management is the discipline of forest economics. Other sciences, ranging from silviculture to political science all play important roles and coordination and balance among the different sciences is necessary. Economics, however, plays a pivotal role. Economic analysis provides information vital to decision making and economics is directly concerned with the science and art of decision making-- with allocating scarce resources among competing ends. Forest economics can be more than just another science to the Forest Service, it can be a "way of thinking."

Currently in the Forest Service, economic analysis is often performed because it is a required step, but not integrated into the overall decision making. It often appears that the Agency does not know how to use economists or how to integrate economic analyses into the mainstream of planning and decision making. The irony is that virtually everyone interviewed in this study acknowledged that economic principles and analyses are important to the Forest Service, that more should be done, and that more Agency personnel should receive economics training.

Evaluation and selection among alternatives is a major use of economics in the Agency. Financial criteria, Present Net Value, and regional economic impact are all developed. However, there is little done in further sensitivity analysis or economic evaluation of preset standards and guidelines.

Cost determination is currently another major activity for many economists at the forest and regional level. This work is prompted by the below-cost timber sale issue. Benefit measurement, especially for resources other than timber, is of great interest and use is made of the national and regional nonmarket values developed by the national Resources Planning Act staff. However, there is wide disagreement over the use of such material, methodology for nonmarket valuation, and the basic philosophy of valuation.

Regional economic impact, in general, is understood by everyone and much is done, usually based on the IMPLAN model. However, the basic principles and assumptions of the

model are often not understood and some attempts to make information more available to forests and districts are not seen as useful.

There are several reasons why economic analyses and economists are not yet in a central arena in much Forest Service decision making. There are problems of the Agency, problems with economists and economics as a science, and some general problems.

Recognized leadership for economics at the national level does not exist. In contrast, most other disciplines and staffs have an identified group in the Washington Office to coordinate, provide direction, and advance their subject at the national level. Policy Analysis includes providing leadership for economics in its mission statement, but more visibility and activity is needed if this part of the mission is to be accomplished.

Economists in the Forest Service are found in the National Forest System, State and Private Forestry, Forest Service Research, International Forestry, and Programs and Legislation. However, coordination and cooperation between the divisions must be strengthened. Some good examples of cooperation exist but in other cases there is a lack of cooperation, duplication of effort, failure to match available expertise with needed analysis, and some unproductive competition for budgetary resources.

Economics as a discipline has some shortcomings. There has been too much emphasis on quantitative analysis and not enough on the interpretation of analysis. Economic jargon and theory are not well understood by many Agency personnel. Economists sometimes disagree among themselves as to methodology. Often this disagreement is trivial and will not significantly affect results but it does lead to arguments and confusing results presented to decision makers.

There is a strong biological bias of many Forest Service professionals. The concepts of marginal analysis and evaluation of tradeoffs is not central to their academic training or professional orientation. Economic analysis often leads to suggested answers that do not agree with these biases. The economist is sometimes seen as a heretic or threatening the power of other disciplines. This problem is not unique to the Forest Service but occurs in many resource management organizations, public and private.

A major impediment to good economic analyses is the lack of good production functions. This problem is also not unique to the Forest Service. In all natural resource and environmental areas there is a paucity of information on the specific relationships between alteration of an ecosystem

and variation in the levels of desired outputs. However, the Forest Service faces a critical need for good production functions as it strives to acheive a balance between the competing public wants, Congressional mandates, and budget realities.

Improved use of economics in the Forest Service depends on several different actions. There is no single panacea, but implementation of recommended actions can be done without major budget impacts or program disruptions.

The Forest Service must develop a clear statement as to the role of economics in the Agency. This is a high priority and can help in making some other changes. There should be clear identification of a Washington based group for economists. This group should coordinate economics across all divisions of the Agency and implement other ways of improving economics.

Economists in the Agency must concentrate on developing useful information for decision makers and show how they can help line officers improve their performance. Line officers and others, should be given frequent training and assistance in developing economic analyses. The development of practical, computer-based economic analysis tools for use by noneconomists, as currently done in several regions and Washington staffs, should be encouraged. All analyses should contain more sensitivity, probability, and risk calculations.

Promotion and transfer tracks for economists should facilitate movement into line officer and higher staff positions. The reward system for line officers should, in turn, include more on efficiency and cost cutting, and less on meeting timber targets.

Finally, economics can play a large role in the "New Perspectives" by concentrating on the basic strengths and principles of the field. A new field is not needed. Rather the existing principles should be applied to the new emerging "ecological" applications.

A major concern of this study is that it lead to improved use of economics in the Forest Service. Much time, effort, and financial resources went into the study and many people shared information and provided useful starting points for future actions. The question is, where to go from here?

It is recommended that a small Task Force be organized with general guidance given by the College of Environmental Science and Forestry at Syracuse. It is recommended that the Task Force include the following from the Forest Service: 2 or 3 regional economists; 1 or 2 economists from

Washington staffs within NFS or P&L 1 or 2 economists from Research especially the Director of Forest Inventory, Economics, and Recreation; an economist from State and Private Forestry; a Policy Analysis economist; and Dr. Tom Mills. From outside the Forest Service the following groups would send economists: National Forest Products Association, Audubon Society, and possibly 1 or 2 other organizations. The Task Force would also include 1 to 3 economists representing other Services within the Department of Agriculture. Coordination and leadership of the Task Force would come from economists at the College of Environmental Science and Foresty at Syracuse.

The intital goal of the Task Force would be to decide what to do next. Three steps would be followed. First, each member of the Task Force would read and analyze this study report. Second, there would be a conference, at Washington, Syracuse, the Pinchot Institute at GreyTowers, or other location, at which the Task Force would assemble and discuss the report, focusing on the specific recommendations. Third, the Task Force would develop specific action items, a time table for acheiving them, and measures of satisfactory acheivement. It is recommended that the Task Force be organized by early 1992 and that the conference be convened in late spring or summer of 1992.

INTRODUCTION

Study Objectives

This study was undertaken by the author as a special study while on sabbatical leave from the College of Environmental Science and Forestry, in conjunction with the Policy Analysis Staff of the Forest Service, United States Department of Agriculture. The study was designed and conducted with full cooperation of, and close contact with the Policy Analysis Staff. The specific objectives were:

1. To determine how the models, methods, and principles of forestry economics (and related operations research techniques) have been applied and used in the National Forest System of the Forest Service, with emphasis on recent and expected near future uses. Included also is some attention to use of forestry economics by the divisions of State and Private Forestry and Forest Service Research, but these are secondary.

2. To explore shortcomings in the use of forestry economics and in the training and use of forest economists within the Forest Service. Included are the findings from forest economists, other support staffs, and line officers.

3. To develop recommendations for policy and program within the Forest Service, training, other education, and research by both Forest Service and Universities.

4. To collect a set of "real world" examples of the use of forestry economics within the Forest Service that can be used in classroom examples and exercises.

A fifth objective was for the author to get a better understanding of the Forest Service, its methods of operation, personnel, and the geography of the National Forest System.

Methodology

The study was carried out by conducting a set of indepth interviews with a variety of people within the Forest Service. (A complete list of those interviewed is found in the Appendix.) People interviewed included both economists and others in the Washington Office, Regional Economists and other staff in the regional offices, several

Regional Foresters or Deputies, some Forest Supervisors and District Rangers, and some Forest level staff, mainly economists, analysts or planners. In all, 94 interviews were conducted.

Persons selected for interviews were based initially on discussions with Policy Analysis staff and the author's knowledge of who might provide enlightening material. Subsequently, while interviewing this first group (mainly Washington Office staff) names of others were solicited. All Regional Economists and related people were to be interviewed. In addition others selected by the regional economist and some selected by the author were interviewed in the regional offices.

It was impossible, within the time and other resources for the study, to conduct a statistical study of the Forests in each Region. Instead, Forests were selected either because they offered convenient locations in traveling from region to region, or because certain forests, suggested by interviewees in the regions, offered useful contrasts and had personnel who could give useful insights.

Persons interviewed were asked about the following areas:

1. (If an economist) What do you do and what use do you make of economic models, principles, etc? If the person was not an economist the initial area asked about was, how does economics enter into your work and what use do you make of economists?

2. What are some of the problems and difficulties in using economics within the structure of the Forest Service, and what are some of the problems in dealing with economists?

3. What would you suggest for correcting the problems identified with economics and with economists?

In addition, any example of the use of economics that could be expanded on was pursued. Many written reports and several computer spreadsheet examples were collected in addition to useful oral descriptions of situations and uses of economics.

Limits

Within the confines of time and other resources it is felt that this is a very comprehensive study. It is not intended to be a statistical study but an overall problem analysis with recommendations given that are workable and

capable of addressing the identified problems. However, as with any study, there are certain limitations that should be kept in mind.

First, the study has the limitation of being a product of the author's background and ability to correctly interpret the interviews. The author has an extensive background in interviewing and in all cases asked questions if some point was not clear. Extensive notes were taken during the interviews. These served to record important points for review later and also helped to fix an idea in the author's mind.

Second, the people interviewed might have told the author, "What they thought he might like to hear." However, the author took time to establish a rapport with the person being interviewed. All those interviewed seemed at ease and willing to talk. The author kept the conversation going and on the desired topics, however, care was taken to not stop or interrupt a person's line of thinking. The people knew in advance, from contact with the author, what subjects were to be discussed, and the background and objectives of the study. In addition, it was stressed that each person's comments would be confidential, that the study was the author's and that the author was not a "Hatchet man" from the Washington Office.

Third, the only persons interviewed were within the Forest Service, with an emphasis on National Forest management and related areas. Several people in State and Private Forestry and in Forest Service Research were interviewed. However, this is not an extensive analysis of forestry economics research done by the Forest Service. If people outside the Forest Service were to be interviewed about the Service's use of economics, it is possible that different ideas would develop. However, that was not the objective of the study.

Finally, it should be pointed out that what constitutes a problem can be difficult to determine. Interviewees were generally asked why such and such was a problem but there was limited probing of some of the identified problems or solutions. Those that appeared major to the author or that appeared to offer workable solutions were studied and examined. Perceptions of peoples' behavior or goals is definitely considered to be eligible for classification as a problem. Many problems within an organization result from lack of communication, understanding, or respect for other professionals. However, a person's perceptions usually guide behavior and to the extent that perceptions differ among different groups there can be enormous problems.

USE OF ECONOMICS IN THE FOREST SERVICE

Outline of Forest Economics

Forest economics, like any discipline, has various uses, and can be outlined in a variety of ways. To describe the use of economics in the Forest Service is is convenient to think of the objectives of economics, the different methodologies, and the different applications and use levels.

There are many disciplines that a decision maker, in the Forest Service or elsewhere, must call upon for intelligent allocation of scarce resources--for decision-making. Economics is one of those. In a larger sense, however, economics is unique in that it deals with human actions directly and attempts to set forth in logical, explicit fashion, the principles and models by which humans can acheive goals. Not just so-called "economic" goals, but any goals, objectives, or ends. That is, economics is not just another discipline to call upon in decision-making, it is also the science of decision-making and of allocating scarce resources.

Objectives of Economics

Describe and Explain - One of the important objectives of the discipline of economics is to help describe and explain human activity and events. This description might be an end in itself or be an input to problem analysis and solution in decision making.

The objective of describing and explaining takes on some formal roles within the Forest Service as in the national studies of supply, demand, and forecasts of consumption and use of resources. However, another role is the informal use. This can occur at all levels of staff and line officers but was most evident at the forest and district levels. Here, rather than a formal analysis of supply and demand with econometric studies of elasticities, economics is a "way of thinking"; a way of looking at situations. Some evidence of this was found and some field line officers showed a keen understanding of market forces, investments, and economic behavior. However, some regional staffs (noneconomists), when asked about some particular local or regional situation, offered an explanation that completely ignored an economic rationale. This is to be expected given their other professional orientation. However, given the particular uniqueness of economics as set forth above, it points up the possible need to give all staffs a feeling of economics as a "way of thinking."

Evaluate and Select Among Alternatives - This is often thought of as the major role of economics. And in the Forest Service it is certainly one of the major uses of economics. Mention was made, and examples shown, where various alternatives were compared and achievement of goals measured by models and units used by the economist. Forest Plans as required by the National Forest Management Act (NFMA), and environmental impact statements, are typical examples of development and choice among alternatives. However, there are some noticeable cases where alternatives were not developed, for example, in standards and guidelines for forest plans. There does not appear to have been any consideration of alternative sets of standards and guidelines.

At the project level there is some development and selection from among several alternatives but this is often dependent on the particular line officer's directives or regional availability of readily accessible computer models.

In cases where some action is explicitly forbidden by law, or where a law or regulation specifically identifies some particular action, there appears little evaluation of possible alternatives. The unfortunate consequence of this is the lack of any explicit recognition of the opportunity costs or tradeoff costs and benefits of alternative actions. Such analysis could contribute greatly to a further understanding of the costs and benefits to society of different laws and serve as a rational basis for possible modification. For example, analysis of the timber income foregone by not harvesting within the zone of the Red Cockaded Woodpecker or Spotted Owl habitat, or recreation visitor days forgone by not providing access into designated wilderness areas would permit the Agency, various publics, and Congress to determine the true costs and benefits of management alternatives and legislative mandates. This point, as a problem area, and possible solutions, is developed in later sections.

Analyze Achievement of Objectives - Economics is the major discipline for determining the degree to which a goal has been efficiently achieved. It is also a major tool in evaluating equity considerations, or who pays and who benefits.

The Forest and Range Renewable Resources Planning Act (RPA) and the National Forest Management Act (NFMA) both specify that efficiency analyses shall accompany all major decisions. Economics direction from Land Management Planning and manuals also indicates this. As a result there has been widespread use of present net value (PNV) calculations. It was pointed out however by many interviewees--economists, other staffs and line officers--that the most efficient alternative, as measured by PNV, was

not always the one selected. Other considerations often entered into the decision. In some cases the decision maker fully recognized the tradeoff, or opportunity cost. In other cases it was not explicitly recognized.

Equity considerations have been looked at within the Forest Service often through economic impact, as embodied in the input-output based IMPLAN model. This is not by any means, a complete examination of equity considerations but the IMPLAN model and its widespread use has heightened consideration of equity as a decision criteria. Aiding this is the relatively easy understanding of the general concept of economic impact, as contrasted to concepts of discounted future revenues and costs using interest rates. However, as shown in a later section, many times IMPLAN results are used without any understanding of what is being measured.

Use of Various Models and Methodologies

Terminology - There is not much activity in this area in the Agency at present. The manuals and handbooks have generally adopted standard terminology used in the discipline of economics and used by writers of forest or resource economics texts. Noneconomists interviewed sometimes used the wrong term when describing something and often expressed concern over economics terminology as being one of the problems with economics (see later section).

Production Functions - There is a definite division among those interviewed about this topic. Most economists and many line officers or other staff persons felt that not nearly enough was being done to develop useful production functions. However, some staff persons, notably in wildlife or soil and water, felt that they knew enough about the relationships between inputs and outputs for a resource.

It was often mentioned that one of the unique contributions of economics and of economists was the focus on production functions. In addition it was often mentioned that economists were of great help in defining objectives and stating them in terms that could be measured. However, some objection was raised to the concept that everything could, or should, be quantified.

Some interesting work is being done in regions and on forests by economists, analysts, or planners to develop local statistical production functions, usually using a regression model. This work seems to be done by people with particular statistical knowledge and interest. Sometimes there is close work with the particular resource specialist and in other cases the economist/analyst has obtained data directly from field studies or literature.

Cost Determination - Forest planning, tighter budgets, below cost, TSPIRS: all these activities and events have provided much impetus to identifying the direct financial cost of different forest management practices. Indeed, this is one of the activities of economists that is most often mentioned and often looked at favorably by others.

Although there is attention to cost identification there is less attention given to determining marginal costs. Emphasis is on recording accounting costs. As such the cost data is sometimes of limited use in planning and budgeting.

Several computer models have been developed in different regions for District staffs to use in recording cost data. The emphasis has been on making something simple and easy to use by someone with very little computer literacy.

Benefits Measurement - In timber the move is away from appraisals and to transactions evidence for setting minimum prices. There is activity in both the Washington Office staff and in some in the Regions to study the method and relationships among different independent variables.

In the nontimber resources, there is wide variation in philosophy, understanding of methodology, and techniques for benefit measurement. There is no clear pattern between economists, resource staffs and line officers or between the Washington office and regions. Several different groups, or schools of thought, exist. One group favors getting at nontimber values solely by the opportunity cost approach. That is, merely stating the value as the tradeoff, or foregone revenue from timber. A second group firmly believes in and strongly advocates the use of nonmarket valuation techniques especially contingent valuation. A third group rejects the idea of a financial value being set on anything that is not actively traded in the market place.

Directives and regulations often prescribe the use of financial values in different documents and these requirements are met but there is often little or no use of the information in decision making. The RPA values are widely used for nontimber values. It is interesting to note that while local prices are used for timber, usually regional or national "values" are used for the nontimber outputs. Often staffs are willing to use a given regional number feeling that there would not be much difference if a localized study was done. Sometimes the statement was made that the regional staff did not have either the time nor the expertise to conduct a separate nonmarket valuation.

Some of the economists interviewed did not comprehend the valuation of nonmarket outputs, either by contingent valuation or other techniques. Many of the other staff and

line people also did not comprehend these valuation techniques. However, if someone had attended one of the training sessions or shortcourses on economics put on by various Forest Service personnel throughout the country there was a greater probability that they at least grasped the rudiments of nonmarket economics.

There is confusion over the total willingness-to-pay values versus the market clearing prices as given in the RPA reports. The derivation of market clearing prices for nonmarket values obtained by contingent valuation or travel cost models rests on assumptions that require knowledge of economics beyond that possessed by most noneconomists. In similar fashion the derivation of total willingness-to-pay values for timber also rests on further knowledge of economics. In both instances these assumptions are subject to question, hence, even the expert could feel quite uneasy about which number to use--total willingness-to-pay or market clearing.

Supply/Demand Analysis - It has been said that economics came to the Forest Service with passage of RPA and NFMA. This is not completely true since economics research had been going on for many decades. One of the hallmarks of Forest Service research in economics were the periodic national timber supply and demand analyses. However, the new national resources planning and the new forest level planning ushered in during the 1970's surely gave rise to a greatly expanded role for economics in the National Forest System. The new planning also brought economics to the regions and forests.

Very few formal supply/demand analyses seem to be done at the regional and forest levels. This is not necessarily a fault and it can be argued that such formal analyses requiring much data and elaborate econometric models that consume large amounts of time and money are probably not justified. However, as the Forest Service attempts to bring management and analyses down to the lowest level, closest to the field resources, more analysis of local supply and demand would seem to be desirable.

In many cases the persons interviewed had a good grasp of local demand for timber and of the National Forest supply in relationship to overall regional supply. It was also found that often managers and staff had fairly good knowledge of the general elasticity of supply for the different resource owners around the National Forest, although the noneconomists probably do not recognize elasticity as an economic term.

For the nontimber resources there appears far less knowledge of local or regional supply and demand. In certain activities such as downhill skiing there is

reasonably good knowledge of supply but even here there are only vague ideas of the elasticity of demand.

In many cases the assumption seems to be that the National Forests have an almost monopoly supply of certain nontimber resources and almost any price will result in the same use; a completely inelastic demand. While this may be true in some cases, explicit study of this would appear to be warranted as it affects pricing and ability to attract consumers. The local demand for nontimber resources, notably recreation and hunting and fishing is often, by benign neglect, assumed to be very inelastic and almost infinite. This is highly questionable but this rather shakey assumption does lead to further development of almost any facility. That is, it is easy for a manager to justify anything if one assumes that the public will consume whatever is made available. Again, the various training sessions conducted, notably in wildlife for wildlife staffs, have helped to overcome this shortcoming.

Forecasting, another part of supply/demand analysis, has been done for a long time at the national level in economic research. At the regional and forest level the implicit, or nondeliberated, forecasts of future conditions appear extremely variable. Often there is very little justification for believing in a certain future condition except that it fits with a staff or line officer's desire to do certain things.

Efficiency Analyses - Provisions of the NFMA and regulations promulgated from it through the Land Management Planning Staff at the Washington office have dictated that forest plans will contain an economic efficiency analysis. Handbooks further specify that Present Net Value is the preferred measure of efficiency and that a 4 percent discount rate shall be used. As a result of these directives, all forest plans and some projects have an economic efficiency analysis performed. However, when discussing this with interviewees many said that the analysis was just to meet requirements and that it was not used in making a decision among alternatives. Conversely, many of those interviewed said that the economic efficiency analysis was used but that it was just one of the factors. They felt that the economists often got upset if the "most efficient" alternative (the one with highest PNV) was not chosen, but that the economist must realize other criteria necessarily entered into the decision.

With the relatively recent below-cost issue in timber there has been more cost-effectiveness analysis. That is, there has been more analysis at the project level of the least cost alternative. This is not a classical PNV analysis but concentrates on just the costs. Some regions require that every timber sale have such an analysis and the

regional economist or other analysts have developed computerized routines, usually Data General based, that enable district personnel to rapidly complete a least cost analysis. Often in these models there are regional or forest level default numbers for various categories of cost. Districts usually use these but with local expertise or assistance from the regional experts some have inserted district level costs.

Another major factor contributing to much of the least cost analysis is the TSPIRS report. At the regional level there will always be one forest that has the highest unit cost. Furthermore, for most of the regions except 5 and 6 most of the timber programs are "below-cost". Therefore, in the annual TSPIRS report, forests can be compared and if yours is highest, there will often be an incentive to at least explore why. Often, in an effort to bring unit and total costs down to some lower level there is a detailed study of different costs including some attempts at marginal analyses.

Some of those interviewed spoke about break-even analysis but very few appear to be doing much. However, both from discussions and viewing the difficult kinds of tradeoffs that must be balanced, it would appear that a type of break-even analysis referred to by the author as "Benefit/Cost Break-Even Analysis" (see copy of author's article in Appendix to this report for an example) would be very helpful. Some of the economists mentioned that they were trying to do this and some felt that this was the best way to inform the line officer about the tradeoffs between timber and nontimber outputs. Also, some line officers stated that they would appreciate having this information. That is, they would like to know what the annualized return or equivalent annual financial benefit would have to be to just breakeven on a certain practice. A modification of this concept has been used in fire and insect control for some years and some economists, usually assigned to State and Private Forestry, are developing and refining models for application to these areas.

Virtually no analysis appears to be done of the effects of inflation and risk. Also there is almost no work being done on effects of different interest rates nor on sensitivity of PNV etc. to different levels of costs and revenues. The reason usually given for this lack was that the regulations specified certain procedures etc. and why do more. Also, it was felt by some economists/analysts that decision makers did not want more information, instead they wanted just the minimum numbers. However, a somewhat different view came from the line officers. They generally felt that they wanted the "bottom-line" answer from the economist but would like to know what the major sensitivities might be.

Economic Impact - If there is one apsect of economics that appears to be most used and appreciated, it is economic impact analysis, embodied in the IMPLAN model. Surprisingly however, even here there is not universal agreement. Some of those interviewed felt that the multiplier analysis was irrelevant, that there are too many assumptions and errors in the IMPLAN coefficients and that just the direct impact was useful.

IMPLAN analyses were usually done at the regional office by the economist or other similar analyst. The impact area definition sometimes received careful attention and sometimes was treated very casually. As in all models and techniques, there was wide variation in the knowledge of input-output techniques and in the pecularities of the IMPLAN model.

Rural Development - This is a general term but it has become of special interest recently in the Department of Agriculture. Funding of special projects to help dependent communities adjust to changes in National Forest management has led to several economist/analysts spending time developing and reviewing proposals. Much of the activity revolves around projected economic impact of a proposed activity. Another large activity is working with local groups, helping them develop a proposal, and reviewing the proposal for technical accuracy in economic and financial matters. Some of the proposals deal with enhancing secondary wood manufacturing or shifting to a wood processing facility more adapted to small diameter, second growth material. Some proposals involve development of recreation facitilies. However, some proposals are well outside the traditional forest and related natural resource areas. There are proposals for developing half way, or modified correctional facilities, and for developing specialized meat processing facilities to meet the special needs of various ethnic groups. These are interesting applications and challenge the resource economist to learn new areas.

Economic Analysis Applied at Different Levels and Resources

Program Planning and Development - The Land Management Planning regulations specify that economic analysis will be part of the development of Forest Plans. (It should be noted that in the proposed revised LMP regulations the use of economic analysis is very much left to the discretion of the Regional Forester.) How the results of an economic analysis are actually used in decision making is quite variable. It is mainly a function of the knowledge and interest of the decision maker, i.e. the responsible line officer.

FORPLAN was, and continues to be a major activity in planning. However, it appears that much of the FORPLAN use was because the model was virtually required. The sharp focus on FORPLAN and belief in it as providing the ultimate answer as to the "best" plan may have been an error. Much of the effort in using FORPLAN was in getting detailed data and making numerous computer runs. It would appear better to have spent more time on refining some of the basic relationships inherent in the linear programming data and more time on sensitivity analysis of alternatives. Unfortunately, just getting a computer run completed often used up all available time and financial resources.

Some regions have developed guidelines for economic analyses to be done by forests. Other regions provide assistance to forests upon request. Often a computer based analysis model forms the core of the guidance. There does not appear to be any specific mandate from the Washington office to develop these regional economic guidelines. Instead their development stems either from interest and direction from the Regional Forester or the interest and time, by the regional economist or counterpart, to develop guidelines. The regional economists, planners, and other analysts are often faced with numerous requests from forests for assistance. It is sometimes after having to deal with many of these that some overall regional guidelines and procedures have been developed.

Region 2 has one of the most elaborate regional procedures for both program and project economic analysis. DGECON is a computerized, user friendly model that runs on the Data General.

Budget development - Very little economic analysis appears to enter directly into budget development. The major reasons given for this are the time constraints and the lack of trained analysts at the forest level. Many people at the regional level, when interviewed, said that supposedly the economic analysis took place when the forests developed their preferred alternatives. However, forest personnel interviewed indicated that the amount of analysis depended on the availability of an economist/analyst on the forest and there are not many forests with large analysis staffs.

Most budget and planning people expressed a strong desire for more economic analysis to be done in budget formation. Often there was a comment at the regional level that there should be a shift from emphasis on managing the current budget to more on developing future budgets. Region 9 has taken an interesting step in this direction by placing more of the operational decisions and current budget allocations down at the individual forest level.

Project Analysis - The amount of economic analysis done on individual projects depends very strongly on the line officer's interest and knowledge of economics and on the availability of someone with training in economic analysis. It was pointed out several times that the younger foresters sometimes have more knowledge of economics and of computer-based analysis than older employees. Continuing education efforts of the Forest Service, particularly the Silviculturist Certification programs with the inclusion of economics as part of the program were often mentioned.

Economic analysis at the project level is often done if there is a critical issue at stake. However, the mere size of a project is not important. Some million dollar ski area developments are not getting economic analysis (in this instance the line officer expressed interest in having an economist available, just to ask the right questions) while some very small projects are. Below cost timber sales are often referred to as needing careful economic analysis. However, this often comes down to documenting very carefully the relevant costs borne by the Forest Service. In some instances this has gone further to analyzing how to cut costs or what the nontimber costs and benefits are. Again this ties into TSPIRS.

A further factor in the use of economic analysis at the project level is the availability of a user friendly computer model or structured process and training in its use. Examples around the regions would be DGECON in Region 2 and the procedure Choosing by Advantage in Region 4.

Resource Analysis - At the Washington level, in the Regions, and on Forests there is general sentiment that economic analysis should be one factor that is always considered in decision making about timber, wildlife, range, recreation, water etc.

Timber with its long history of models and concern in the field of forest economics has the most detailed economic models readily available in the literature. However, even though forest economics texts spend much time on the subject of optimum rotation there is very little attention to this subject in the Forest Service. Some regions mentioned that the subject was of interest and that the Forest Service should look at rotations from the standpoint of being efficient with taxpayers' money and public investments. Interestingly, there appears to be almost a backlash, recently, against economic analysis, by some timber staffs. There is some feeling that an economic analysis might work against timber given the attention to nontimber values.

Wildlife and other recreation projects have recently embraced economic analysis yet there is strong opposition by some wildlife staff and others as to the appropriateness of economic analysis for any nontimber, nonmarket forest output or service. However, the nontimber staffs have begun to realize that economic analysis often gives them another strong argument for carrying out projects. Economic analysis would probably not be pursued so much if the answer worked against project development.

A useful example of how an economic analysis gets started is provided by the experience on the Shasta-Trinity National Forest concerning the Trinity Reservoir. (Other examples were shown the author but this one is particularly illuminating.) This Forest currently has a major problem with the drawdown of the water level in the reservoir, due to current drought and needs of the central California Water Project. Boating access ramps and fish habitat areas have been lost. Technology exists for creating movable ramps and for creating artificial fish spawning and shelter areas but the question is the justification for the expenses. The recreation planner on the forest, knew of the problem through the District Ranger. While attending a recreation shortcourse the use of contingent valuation was explained. Details of the model did not necessarily mean too much but what was very important was the particular example used in the course. It was people's reactions to varying the levels of a reservoir on the Tennessee Valley Authority system. The planner immediately saw a similar application of the model on Trinity Reservoir. The lesson learned from this is, it was not so much the theory shown in class but the particular example that focused attention and stuck.

Engineering, especially roads, have long incorporated some economic analysis in their planning and development. In many cases the engineering staff works separate from the economists and other analysts. However, at the District and Forest level, the engineering staff is often the only one with computer and economics skill readily available for a forester or other staff person.

Fire, and more recently insect and disease, have had attention in development of regional economic models and computer-based routines. This activity is most often carried out by economists/analysts attached to State and Private Forestry.

Uses and Roles of Economists

For purposes of this study an economist was considered to be any person who filled a position identified as economist, or whose job included a major portion of time devoted to the activities described in the above section.

In some cases the individuals called themselves analysts or were called this by others. In this report the term economist/analyst is often used to emphasize this broad interpretation of economist.

A listing of all persons in the Civil Service economist series in the Forest Service was initially secured. However many economists were discovered to not be on this list. For example, excluded were all those on the Policy Analysis Staff. Because of grade and position titles most of these people are considered Interdisciplinary Analysts or Foresters. In other Washington office staffs similar situations exist. In addition several other people were discovered, mainly in regions or on forests, who function full time as economists, or closely related analysts.

Education - Education of the wide group of people considered economist/analyst is very variable. At the Bachelor's level the degree might be a B.S. in forestry or a B.S. or B.A. in some other area often including agricultural or resource economics, general economics, or business management. Many economist/analysts had advanced degrees with a M.S. in forest economics being most common followed by a M.S. in agricultural economics or M.B.A. in business management. A surprising number of Ph.D. forest economists were found. Keep in mind that this study focuses on National Forest Management, not on research. The author was familiar with the many Ph.D researchers in economics in the Forest Service but the number of Ph.D forest economists in National Forest Management was a pleasant surprise. Two different Forest Supervisors stated that they would want a forest economist with (among other things) at least a Master's degree and preferably a Doctor's degree in forest or resource economics on their staff.

Some economist/analysts interviewed had no formal degree-related education beyond the Bachelor's level but had completed much additional training through inservice courses and other training. Others had completed specific courses in economics or related quantitative methods at local colleges and universities.

Duties of Economists - Economist/analysts were found doing many different duties, or tasks. In some cases the tasks resulted from the individual's desire and ability to pursue a certain area; in other cases the task resulted from an assignment by a supervisor. The different duties are as follows:

General advice and consultation
Specific assignments and data analysis
Review and comment of other's work
Model development
Teaching
Applied research

General advice and consultation was a task performed by almost all economist/analysts interviewed. At some point they were called upon by others in their office, by lower units, or by higher units, to give specific help in solving a certain analysis problem or to provide the particular viewpoint of an economist.

Specific assignments, usually involving quantitative data analysis, were done by many economists, but many did not do any data analysis.

Review of the analysis done by others was a task done by most economists interviewed. Environmental Assessments or Environmental Impact Statements were the typical documents reviewed.

Model development was done, as mentioned above, by many economists. This activity most often involves taking relatively simple efficiency analysis or IMPLAN analysis and developing a very user friendly computer routine for noneconomists to use. The users are often located at forests or districts and the economist at the regional office.

Teaching is a task performed by a surprisingly large number of the economists interviewed. This teaching often went along with the development of a specific model or technique. Teaching was usually aimed at other, noneconomist staffs, or in some cases, as part of a team taught session for line officers. These courses ran from one day to several, usually less than a week.

Applied research was performed by relatively few of the economist/analysts interviewed. Beginning production function quantification and other regression models for relating several variables such as in campsite development, were often the activity.

A Characterization of Economists Interviewed - The economist/analysts interviewed in this study seemed to be divided into four groups. No one individual fits exactly in one group. Nor is it intended that one group is any better than any other. It must be recognized that different individuals have different personalities, abilities, education, and opportunities. The four groups are as follows:

1. Assigned specific tasks (usually closely related to forest planning) and performing the job. - This is a large group of people who go to work and do their job without too much concern. They follow directives and regulations and get the assigned task completed.

2. In planning (or closely related specific area) but uncertain of what to do. - This group, relatively small, but potentially growing, has been assigned to forest planning but are in locations where that activity is slowing down. In some cases this group includes relatively new assignees to the position. In all cases this group is trying to carve out a niche for themselves. Often, direction from supervisors is minimal or the supervisor and line officer are not sure what they want the economist/analyst to do.

3. Involved in many tasks, busy, enthusiastic - This group is also small but might be enlarged with the right incentives. This group consists of individuals who are involved in a wide variety of the tasks described above. Their enthusiasm is infectious. They are very busy and are well respected by their supervisors.

4. Unhappy workers - This group, the smallest yet, represents the undercurrent of discontent that surfaces more and more in the Forest Service. (The Forest Service is not unique in this; any large organization, public or private, has its "radical fringe.") This group contains many potentially highly productive people. With correct incentives some of these individuals might easily become a member of group three above. However, members of this group constantly find fault and almost seem to revel in criticizing the organization.

PROBLEMS WITH ECONOMICS IN THE FOREST SERVICE

This section describes the different issues, difficulties and problems of using economics in the Forest Service as described to the author by the interviewees. The items described herein are not unique to any one individual. In many cases similar ideas were expressed by economists, other staffs and line officers alike.

It is always possible to find problems with one's organization, or with one's peers, even with oneself. Public agencies, universities, private firms, and charitable organizations all have their shortcomings and someone can

always find fault from within. Many of the problems and issues described herein might be very similar to those faced by other agencies and also similar to those faced by other disciplines within the Forest Service. These problems should not be viewed as a condemnation of either the Agency nor of economics but the honest attempt by concerned individuals to develop ways for strengthening both their agency and the use of a well recognized discipline--economics--in carrying out the mission of the Forest Service.

The material is divided into three subsections: problems of the Agency, problems of economics and economists, problems in general. No attempt is made in this section to develop solutions, nor is there much general synthesis of problems. Those topics are taken up in later sections.

Problems of the Agency

The Forest Service does not know how to use economics - Economic analysis is not yet fully built into Forest Service decision making. Economic analyses are done largely because of requirements. Going along with this is the lack of a reward system for economic efficiency. There is, instead a reward for meeting targeted output levels and spending the allocated budget. Risk avoidance is rewarded; risk taking is to be avoided unless the risk can be shifted to others.

Line officers do not understand economics - Most line officers are thought of as being relatively ignorant of economics and thus not wanting to know what the economist is doing. With this comes a benign acceptance of the economist's analysis but no real understanding. Note that this was a feeling most strongly expressed by economists and other staffs (planners, etc.). The author's feeling is that, based on the line officers he interviewed, this is not a correct representation. However, if this is the perception of various staffs, then there is still a problem.

Economic analysis is often looked upon as giving an answer different from the individual's beliefs - Many of the personnel in the Forest Service have strong biophysical backgrounds and the doctrines that they follow come from their greater exposure to these biophysical disciplines. Economics, focusing on the decision of choice, does not prescribe any outcome but rather how that outcome is reached. This tends to be confusing for some people. In addition, economic analysis is often seen as threatening to different parties. On the one hand, nontimber interests see economics as tied to commodities and not giving their resource a "fair shake." On the other hand, timber staffs sometimes see economic analyses as threatening because of

the inclusion of nonmarket values or because it works against one of their doctrines--e.g.,the doctrine of maximizing large sawtimber production with long rotations.

Economics is often not brought into the decision process early enough - The economist is not always part of the initial interdisciplinary team but is brought in after the decision is made. Sometimes an economic analysis is called for to justify and strengthen a decision that is already made. Going along with this is the rivalry among different staffs, particularly with regard to sharing data. In today's world, information often means power. There appears to be a reluctance, albeit benign, to share data and information with others unless specificially required to do so by higher authority.

An anti-analysis orientation by line officers - There is a feeling that line officers are more interested in meeting the various publics or attending meetings at the regional or Washington office level than getting involved in analysis. Also there is a feeling, by some line officers, that a detailed analysis often did not improve the decision or lessen any subsequent difficulties they faced. Going along with this is probably some "backlash" to FORPLAN. The critique of the Land Management Planning process, comments of those interviewed, and the author's opinion are similar. That is, FORPLAN engulfed all analysts and other staffs, took up much time, resulted in many more necessary decisions, often produced a void in how to implement the result, and ultimately often led to much public controversy.

National level analysis are often kept from regions - The various staffs in the Washington office work on many special studies that many people in regions and on forests feel are unrelated to their mission. Furthermore there is a feeling that not enough input and consultation is done with the field units. This is interesting in that the author learned of many regional and forest personnel who were given short term assignments in the Washington office, or called to be on a special national task force. However, like many of the problems identified herein, there is often a perception of certain conditions. To the extent that incorrect perceptions can lead to difficulties there is a problem which should be corrected.

The Forest Service faces too many crises to take the long term look - There are certain staffs which have been created to correct this problem thus one wonders why the problem was mentioned. As expressed by one person, every time a new problem faces the Forest Service, a new appendage is created to deal with it. However, the problem often lies within the existing structure and could be better dealt with by restructuring the existing organization. Regardless of how the Agency responds, there do appear to be many vastly

different issues and "brushfire crises" faced by each line officer. These in turn must be dealt with by the various staffs.

No Washington Office coordination or leadership for economics - Other staffs each have an identifiable staff counterpart in Washington to provide leadership or coordination among field units. It is felt that this is lacking in economics. Sometimes mentioned was the role that the Policy Analysis staff is supposed to play but that this staff was often too busy working on irrelevant projects and has not been given the same authority as other staffs. Going along with this was a stated lack of networking among economists and no mechanism for them to easily get together and discuss different aspects of work.

Forest Service Research does not concentrate on problems of National Forest Management - There was not a strong feeling that all research in the Agency should be aimed just at the National Forests but that in many instances researchers had not looked at problems that loom large for the Forests and Regions. Reasons for this problem are many and include the orientation of many researchers toward more esoteric and academic studies, the need for researchers to have published articles in scholarly "academic" journals, the lack of funding ties between research and NFS, the often fuzzy thinking of those in NFS as to what constitute genuine problems, and the lack of appreciation that research often takes a long time from project development through data collection to publication of final results.

Problems of Economics and of Economists

Emphasis on quantitative analysis - The highly quantitative nature of many advanced economic studies is seen as a detriment to working with noneconomists. It was sometimes stated that economists try to quantify everything and that is not possible. Some of this feeling centers heavily around the nontimber resources and is probably tied into the psychological belief that it is somehow wrong to try to reduce human experiences to numbers. Going along with this is the problem of economists often being tied very closely to the analytical side of forest planning. This tie was seen as hurting the economist's credibility in some cases.

Belief in economics as the ultimate answer - This characteristic was often cited regarding young economists. Going along with this was the feeling that economists often lack understanding of the role of politics in public decision making. It was usually pointed out that economics was not alone in this. Most of the other staff specialities

had these same problems. Often mentioned were wildlife biology and silviculture. Each discipline tends to look to its own methods and tenets for the correct answer and tends to ignore other considerations.

Addressing problems other than those of concern to the manager - Some economists and the field of economics in general were seen as spending much time on trivial questions or working on problems of no interest to the line officer. It was stated several times that the emphasis on FORPLAN runs and the energy put into this activity was completely misguided. What the manager wanted all along was a solution that would minimize public controversy and that would be "appeal proof." They had no interest in maximizing PNV or acounting for many recreation visitor days, or similar considerations.

Lack of agreement on major points of methodology - This problem tends to center around the issue of nonmarket outputs and their valuation. The field of economics tends to be divided into two camps; those who believe in and understand the methodologies for evaluation of nonmarket resource outputs and those who reject the methodologies and results as meaningless. Another major area of disagreement was the assumptions that enter into the economic impact analyses. Going along with this was the feeling that economists sometimes spend too much time arguing over small points or refining a moot part of the analysis when the manager is really interested in the major conclusion.

Lack of communication with other economists - This comment was heard mainly from the economists. It was felt that regular structured meetings with set themes would be very beneficial. At present, some of the economists are isolated and have no easy way to find out about studies other economists may be working on. Also mentioned was the inability to have someone to review methodology, etc.

Paucity of field experience and field contacts - It was sometimes felt that some economists (and other staff people) have not had enough experience at the district or forest levels. Experience is seen as very useful for the economist to appreciate the problems that concern the field. It was pointed out, and observed, that often field people are brought into the Washington office or to the regional office for special assignments but that there are people in the Washington office who have no field experience. Similarly, it was felt that the lack of field visits by regional economists or by Washington office economists was a detriment. The impersonal use of directives was seen as not leading to enthusiastic participation in any particular activity.

Confusing terminology - The terminology of economics was seen as confusing by some. Terms such as supply and demand are often used incorrectly by laypersons. Demand is often used when consumption is the correct term. In addition it was pointed out that people do not relate well to the concept of present net worth. Instead the pattern, or flow, of wood or other resource output is more recognizable to them. Terms used in nonmarket analyses, especially option and existence values, are considered especially troublesome.

Lack of simple analysis - Sometimes the best analysis is a very simple one requiring very little in methodology and not relying on sophisticated computer models. Indeed, the economists that are seen as successful or very useful to line officers often rely on the simple analysis.

Confusing presentation of results - Decision makers and others, as in an interdisciplinary team, want analysis results simply and clearly presented. For example, a table of numbers may appear complex and confusing, however, graphical presentation of the major points may be very illuminating. Going along with this was the lack of good oral and visual presentation skills.

Following regulations blindly - It was felt that some economist/analysts merely follow the stated regulations and do nothing to customize the analysis to the particular situation under consideration. A lack of innovation and uniqueness in making analyses was seen by some.

Lack of indepth understanding of some models - By their own admission some of the economist/analysts admitted to not fully understanding some of the models they used. In most instances the person was attempting to correct the situation but felt that they did not know enough about the model to use it professionally and that they were merely acting as a technician.

Lack of technology transfer in economics - There appears to be a lack of showing how economics can solve many of the manager's problems. Related to this is a lack of showing other specialists how they can use economics. A criticism often leveled at research is the lack of technology transfer for the person in the region or on the forest.

Economics handbook - This was seen as not being helpful to noneconomists and not being used or helpful even to economists.

Problems in General

Lack of good production functions - Economists, other staff persons, and line officers all relayed the same situation; there is a terrible lack of good production functions, not only for the nontimber resources but also for timber. The lack of these functions was seen as one of the major shortcomings of the previous FORPLAN runs. Some biologists felt that enough was known about the production response of the resource to various management techniques, however, overwhelmingly it was felt that there was a major lack of this information in a useable, marginal sense. That is, there is not enough known about the response of a resource, for example timber, to fewer thinnings, or to a different level of shelterwood cut. In wildlife management, the response of the animals to habitat modification was seen as lacking. The next link, changes in animal population as related to changes in hunter, or other user, satisfaction, was also seen as sorely lacking.

Lack of enough economists to do the jobs - Again, it was not just economists that cited this as a big problem but often line officers. A later section of this report discusses how economics and economists can be helpful to the Forest Service; in this section we merely cite the problem. There were many cases shown when an economist could have made valuable input. In some cases, the only economist available was at a remote location and did not have enough time to become familiar with the particular local situation.

Incorrect use of RPA values - Many people appeared to be using the published RPA values incorrectly or cited an incorrect use of these numbers for nonmarket outputs. The problem centers around the need to put some number in the analysis for meeting requirements and the desire to push responsibility for the accuracy of the number off to someone else. In addition, as mentioned elsewhere, many people using the RPA values do not comprehend the methodology or limitations of those numbers. The derivation and limits are not clearly shown in the publication.

Lack of good data for TSPIRS - This was with particular regard to the economic report. In many cases the information put in this report was merely copied from the forest plan. That is, the information came from the planned or forecast impact. However, TSPIRS is supposed to be an accounting, or after-the-fact report. Again, lack of time or lack of good production function data was seen as the root problem.

Forest Service NEPA process does not utilize economic analysis - Meeting the requirements of the National Environmental Policy Act are seen as just that; meeting the letter of the law and regulation and not of using the NEPA

process to improve decisions. The litigation mentality of current times has led to emphasis on making any decision "appeal-proof" not necessarily doing a good analysis. There is a great reluctance to show the entire basis for the decision. Use of recognized tools such as decision trees and decision matrixes is inhibited by the possible explicit showing of the manager's basis for choice and opening up the case for further appeal.

Forest Service "bashing" - It is always fashionable to level criticism at others and the Forest Service has been criticized by university and special interest groups virtually from its inception. This constant criticism however, has a deleterious effect on the organization. College students enter the Agency with a jaundiced view of it and these perceptions often continue due to lack of contact with all facets of the Agency.

IMPORTANCE OF ECONOMICS TO THE FOREST SERVICE

After mentioning the problems with economics, but before discussing what might be done it should be established just how economics and economist/analysts can be helpful to the Forest Service. This section attempts to do that by listing the focii, or emphases of economics and then discussing how economists can help in the Forest Service. The section ends with a comment on the role of economics in "New Perspectives."

For this section the author is relying on his own knowledge and observations of Forest Service activities and mainly on the information provided through interviews with Regional Foresters, Forest Supervisors, and District Rangers. Interviews conducted with planning personnel are also used here but those with economists and other analysts were not used much for this section. This is important since it is the line officer who will ultimately use the economist. Planning directors and staff also have valuable insights as to how economics can be used while being somewhat more neutral than the economists themselves might be.

The Focus of Economics

Economics as a discipline has several traits that bear directly on decision making and the overall mission and mandates of the Forest Service. While none of these might be the sole purview of the economist, they tend to be the things economics and economists focus on. These are as follows:

looking at situations as sets of alternatives

clarifying goals and objectives

quantifying the time dimension

looking at marginal changes

placing human values on inputs and outputs

inclusion of opportunity costs in analyses

recognizing the equity considerations of who benefits and who pays

asking the "so what" question

Probably the most important skills and characteristics of the above list to the line officers interviewed were: 1) asking the "so what" question and 2) focusing on alternatives. The economist was looked to for interpretation of impacts that Forest Service actions might have on people's wants and needs. In contrast to many other disciplines that focus on the best action, economics tends to consider alternatives without any a priori notion of the best one.

How Economists Can Help the Forest Service

Asking the right questions was something that line officers wanted. This was phrased differently by various people but ultimately meant having someone who would recognize what to ask and what to look for in a set of data or in someone's report or proposal. As one line officer put it, there was a multimillion dollar development planned that would require many Forest Service agreements and concessions but he had no one readily available to examine the proposal for the soundness of the demand, financial investment, and operating revenue analyses.

Doing the analysis is another trait often looked for in economists. Many situations were described to the author that, from an economist's viewpoint, are rather straight forward for analysis, but the line officers stated that they did not have the expertise nor the time to do the analysis and felt that an economist would be the best person to do it. Note that these managers are not calling for extremely high level analysis from an economics standpoint. What is needed is someone with the ability to do a rather simple analysis and to do it correctly and rapidly, without needing to check methodology or learn new techniques. As one person put it, many people understand something about economics but an expert is needed to do a correct analysis.

Interacting on an interdisciplinary team was another major help that economists were seen as providing. By focusing on the items listed in the above section, the line officers felt that the economist brought much discipline and a structured way of thinking to the work of the team.

Teaching and providing expert consultation are roles which may be unique to economists in the Forest Service. There was an expressed need to have someone readily available who was familiar with local conditions who could develop and adapt analysis tools and put these into the hands of the local field people. Through their academic coursework and other training, such as the silvicultural certification programs, many people in the Forest Service are capable of doing some economic analysis. As with any other skill, constant use or retraining is often necessary. In addition there are many staff people whose academic training did not include any economics. For these people a locally available economist could teach the rudiments of economic analysis and work with them to develop some level of competence in economics.

Explaining economic analyses and the analytical models such as FORPLAN and IMPLAN to the various publics is a related teaching activity seen for economists. It was found that plan appeals are sometimes based on economics and at that point it is necessary to have an economist who can dedicate full time to helping on the appeal.

Providing an economic way of thinking and bringing economics out of the requirements phase and into the mainstream of thinking is important. Most line officers and planners interviewed readily admitted that economics was important but that unless there was an "expert" around all the time to interact with, it was going to be difficult to fully use economics tools in day to day activity. Again, to paraphrase one person, many discussions are held at coffee breaks and it would be good if one of the people there was an economist.

Showing the tradeoffs in choosing an alternative course of action and examining who benefits and who pays were other very important things that it was felt economists could do. Most people interviewed felt that there was not nearly enough done in marginal analysis, looking at tradeoffs, and examining opportunity costs. There was no strong feeling that the most financially efficient alternative, as measured by highest benefit-cost ratio or highest present net worth, should be chosen but that the decision maker should know explicitly the tradeoffs and opportunity costs. The economist was seen as the person to develop this information. Paying attention to efficiency and equity are

important not because of rules and regulations but because the Forest Service should be careful how it spends the taxpayers' money.

Finally, economics, like other disciplines, is developing new techniques and has new applications. Someone is needed who could keep up on the current literature, understand it, and recognize when a particular technique or application might have relevance in their particular area.

The Role of Economics in New Perspectives

Economic principles and the expertise of resource economists can make major contributions to developing and implementing the ideas and concepts espoused in the New Perspectives thrust of the Forest Service. The shift to ecosystem management and away from strong timber management calls for explicit consideration of the tradeoffs from different ecosystem outputs and the relationship of these different (marginal) yields to different cost inputs. The New Perspectives also considers private land resources in planning National Forest programs. Inclusion of the private sector requires comprehensive analysis of local supply/demand situations with particular reference to the expected behavior of private landowners to various pressures such as rising property taxes and changes in stumpage prices. Of great importance when blending in the private lands are alternative revenues (opportunity costs) possible from land leasing and conservation easements or from selling to land developers.

New, different forest outputs are being seen as having value, for example, an old stump used for insects or for homes to small mammals and as an adjunct to scenery. What is the value of the stump and more importantly, what are the marginal returns (benefits) from having more stumps? Techniques of nonmarket evaluation and careful analysis of the opportunity costs are needed. The application of opportunity costs to some of these "new" forest uses and outputs can be very tricky. Without a competent, knowledgeable, experienced economist it is possible to inflate and greatly exaggerate the value or to measure the wrong dimension of value.

Traditional forest regulation may require modification under total ecosystem managment. Timing of treatments and production of intermediate outputs become critical. Purely biophysical measures of rotation such as culmination of mean annual growth have never been very satisfactory. With timber as one of the many products, possibly even as a byproduct, of ecosystem manipulation, economically meaningful rotation and stocking concepts must be developed and used.

WHAT CONSTITUTES AN EFFECTIVE ECONOMIST

Regional Foresters, Deputy Regional Foresters, and Forest Supervisors who were interviewed all felt that economists were a necessary part of their managerial team. They were all quite similar in what they felt constitutes the ideal economist. A summary of the characteristics and brief explanation is given below:

Strong in theory

Competent in analyzing reports and data

Good at writing and speaking

Accepts criticism

Gives succinct advice

Effective group member

Sees economics from the manager's viewpoint

It was taken almost on faith that an economist would be strong in theory and have up to date technical skills. An economist would know of developments in the field and could keep abreast of new ones. Several people stated that they would want at least a M.S. degree person and might prefer a Ph.D. trained economist.

The ability to carefully analyze reports and scrutinize data often goes along with high level technical skills but it appears important enough to recognize as a separate characteristic. Managers want the economist to be able to ask and answer the question, "What does this mean to the final situation?" and to ask, "What happens if we change this bit of data by such and such amount, etc.?"

Effective communication skills appears to be a necessity for all resource professionals. It was seen as especially true for the economist because this individual would be interacting with so many different specialists and laypersons, each with different perceptions and overall, little knowledge of economics.

The economist must be capable of accepting criticism and not giving up because the manager does not accept the economist's recommendation. Also, the economist must be able to accept challenges and criticisms from noneconomists and be ready to calmly explain the assumptions and rationale for a particular stance.

The end use of much of the economist's skills is providing advice to the line officer, or other decision maker. They want the economist's best answer, stated in succinct terms. Details of techniques, models and assumptions used to develop the answer should be very well understood by the economist but should not be presented to the decision maker unless asked for. However, along with a "point estimate" or the "answer" the decision makers often wanted to know the opportunity costs and tradeoffs of not pursuing other alternatives. This also must be presented in a succinct manner.

Interdisciplinary teams and similar groups consisting of people with varying backgrounds are the norm in Forest Service planning, analysis, and decision making. The economist is seen as a valuable member of that team, as explained above. Effective group discussion skills, a desire to work with people, and knowledge of conflict resolution skills are seen as needed.

Finally, and a part of all the above, an effective economist can see economics from the viewpoint of the line officer. That is, the economist must know how the line officer relates to economics and to the economist. Knowledge of the subject, other forces bearing on the line officer, and the personal relationships with the economist are all important for the economist to recognize. In summary, the line officer, or manager, and the economist, must work closly together.

POSSIBLE WAYS TO IMPROVE USE OF ECONOMICS IN THE FOREST SERVICE

Many different suggestions were given to the author during the course of the interviews for ways to improve the use of economics in the Forest Service, for improving the Agency in general, and suggestions for universities to consider. Rather than present a litany of those suggestions, the approach in this section is to consolidate those suggestions, consider various themes and include additional thinking and consideration of what might be done. Thus this section is partly a reflection of what came from the interviews and also reflects the author's considered recommendations. The discussion is organized around several themes: policy considerations, number and use of economists, mandates for economists, training, role of the regional economist, general management, university responsibilities in education.

Policy Considerations

Of the highest importance is the need for the Forest Service to develop a clear and comprehensive statement of the role of economics and the place for economists in the Agency. This activity should not be relegated to some separate group but should actively involve all five divisions and respective staffs, regions and forests, and should actively include non Forest Service persons. The statement should be framed as guidance rather than as regulatory, allowing flexibility for the different units within the Forest Service to meet unique local conditions.

A Washington based group should be clearly identified and recognized as providing leadership and coordination for economics in the Forest Service. This group might have a standing advisory committee which would include non Forest Service people. All divisions of the Agency would be represented. Coordination between the Divisions of Research, State and Private Forestry, National Forest System, International Forestry, and Programs and Legislation would be a major priority of this group. Another major task for the group would be coordination and leadership for the regions and forests. In this role it is recommended that a national economics coordinator be appointed to carry out this task as a principal activity.

Research in forest and resource economics (and possibly in other areas) needs to be better coordinated between National Forest System, State and Private Forestry and Forest Service Research. This does not mean that all research should be done solely for the national forests. Clearly the work presently done by researchers has societal benefits far outside the one mission of the national forests. However, closer ties between certain research units and the national forests would provide the expertise needed to develop some of the detailed analyses needed on the forests. Similarly, such coordination could result in significant cost savings for the Agency.

The present study is not an evaluation of research in the Forest Service. However, research, and links to forest management, came up many times. It was also surprising to see the amount of research being done by economists and other specialists in State and Private, in the National Forest System, and in Policy Analysis.

Other changes to be considered in research might be to develop some quick response teams to act on a crisis issue facing a forest. In addition, the evaluation criteria for researchers might be modified to encourage more technology transfer to National Forest problems.

The forest planning process should be carefully reexamined. The current proposed new LMP regulations are good as far as they go but higher level policy needs to considered. An explicit recognition and statement of the role of political and emotional factors in decision making would help clarify goals and objectives both for the Agency and for the various publics involved. Given the present appeals and litigation climate, eventually all of the basis for decisions and the opinions and judgements of the decision makers become public.

In addition, in future planning efforts there should not be so much reliance on high level analytical models but more attention to developing basic resource relationships, values, and clarifying goals and objectives.

Line officers play a crucial role in the use of economics in the Forest Service. Many cases were discovered where the activities of the economist had developed in certain ways because of the particular line officer in charge. Forest Supervisors and Regional Foresters (including deputies) can either support or downplay economics. Where they have been supportive and an enthusiastic economist has been present, there have been wonderful success stories. Line officers do respond to their reward and evaluation criteria thus there needs to be some changes here. Efficiency as a goal should be highlighted. Line officers should also be very closely involved in planning rather than delegate virtually all the planning to a separate team. Again, where the line officer was involved or at least frequently informed and asked for advice and direction the results of planning seem to have been much better for all parties concerned.

Strong, ongoing ties to Universities need to be developed and maintained. The Forest Service has many cooperative relationships with various colleges and universities. However, in the area of forest management there are opportunities for long term interagency transfers and ongoing consultive roles between forest supervisors and university personnel. This study's particular interest is in such a link between university forest economists and the Forest Service, however, there are excellent possibilities for many other disciplines. Semester, or at least monthly joint work by personnel could do much to bring into the classroom the valuable experiences of the Forest Supervisor while at the same time keeping the teacher/economist present. On the Agency side, having a university forest economist work directly with a Supervisor on a daily basis would give the Supervisor ready access to a consultant while giving the University person a better understanding of the job and pressures of the line officer.

Numbers and Use of Economists

More economists to work at the regional and forest level in the Forest Service would be beneficial. These people would fulfill the roles described in several of the previous sections. However, as many of the interviewees cautioned, there should not be any expansion of the economists until the Agency has developed a clear statement of the role and use of economics and of economists, as specified above. A useful concept for the economist's position might be as a "zone economist" with one person serving possibly 2 to 4 forests in a region.

Transfer and promotion tracks for those in economist positions need to be enhanced. Easier possibilities for economists to transfer to line officer positions, to other staff specialities, or to higher positions in regional and Washington offices are suggested. This give economists incentives to do their best to secure favorable promotions and, over the years, more economics thinking would come into active decision making. In concert with other suggested actions economics might eventually be brought out of the requirements phase and into a general way of thinking.

Hiring some specialists such as in planning, budgeting, or economics, at higher grades, without any Forest Service background has been suggested. While the author does place much emphasis on staff people having field experience, there is also to be recognized the extremely valuable contributions that someone without a "Doctrine" can bring to bear on decision making. Often such people are not afraid to ask certain questions and to raise issues that have become part of the mystique or tenets of belief of any organization. Furthermore, the world is changing, more people now look upon employment as a job, not a career.

Mandates for Economists

Economists must demonstrate that they can do a good job. Even more important, they must show line officers and other staff persons how they, the economist, can help the line officer or the other staff do their jobs better. That is, the economist must demonstrate that they can be useful in ways that appeal to their colleagues.

Economists must recognize that economics and the concerns of economists are only one factor in public resource decision making. All staff must recognize the triangular nature of decisions. There are three necessary parts:

1) The substance or "stuff" being decided upon. This includes the technical relationships and data.

2) The process used to decide among courses of action. This is the role most often filled by the economist.

3) The relationships among the various people involved in the decision. This includes how each person feels about the others and their respect and knowledge of the others skills.

Related to the above is the necessity to recognize that five different forces are of concern to the decision maker. These are:

1. biophysical relationships

2. economic relationships

3. socio-psychological relationships

4. legal mandates

5. political relationships

More practical analytical tools must be developed for use by forest and district personnel. This activity has progressed quite far in certain regions but is lacking in others. In this, as in other activities, university faculty can be a big help. However, the regional, or other local economist must be involved since that will be the person to provide onsite expert consultation and training for continuous use of models and tools.

More research and development of nontimber production functions and values must be done. This is not just a responsibility of economists but must involve all staffs. Going along with this is the implicit need for different staffs to work together and to recognize the worth and public need for the other resources.

In valuation of nonmarket outputs it is a mistake to rely solely on the nonmarket values as developed either by national RPA or by localized contingent valuation or travel cost models. Much more must be done to portray the opportunity costs, or lack of them, when blending a nonmarket output in with timber. The tradeoffs among the different resources must be explicitly portrayed.

Decision processes such as the decision matrix, as described in an article appended to this report, or as embodied in the Choosing by Advantage methodology used in Region 4, should become part of all decision making. The claim that the methods are subjective and open to

manipulation of the numbers is nonsense. Any method is subject to these contaminations. The explicit display and recording of weights and importance values is much less subjective than the implicit unknown values and preferences that are usually used. Furthermore, the claim that making weights and preferences explicit will lead to more appeals and litigation does not seem at all warranted.

Economists and other analyst staff people in the Washington office must visit the field more and participate in meaningful ways in decision making, including environmental assessment and planning, at the local field level. The counterpart of this, field people getting exposure to Washington office and national pressures and concerns does take place but that too could be increased.

Economic analysis should concentrate more on risk, probability, and sensitivity analysis. High level, esoteric, mathematical models are not needed so much as a simple recognition that nothing is known with certainty. This then leads to testing results in view of marginal (small) changes in numerical data and in looking at the "what if" questions. For example, there should be more study of the effect of a ten percent change in key variables, or the effect of a greatly decreased, rather than an increased, budget. This type of work can only proceed (barring any large expansion in staff) if something else is given up. It is recommended that less effort be spent on getting the "true" or "completely accurate" data.

Customizing input-output models, which usually will mean refining IMPLAN, for localized conditions is perhaps a small item. However, it was pointed out that many noneconomists relate readily to economic impact analysis. Without careful work, however, the errors possible in impact analysis can be horrendous, and vary widely among different analysts; witness the various employment and income figures generated during the Spotted Owl controversy.

Training

Economists within the Forest Service should have regular meetings with a structured agenda and theme. This would allow dissemination of new techniques, training and updating, and facilitate sharing of ideas. It is recognized that there are economics organizations around the country--e.g., the Southern, Midwestern, Northeastern, and Western Forest Economists groups--that partly serve these purposes. However, Forest Service economists would benefit from having their own separate meeting.

New techniques and refresher courses on existing techniques should be available to economists within the

Forest Service. University faculty could be called upon (given modest financial resources) to conduct short courses. In providing this type of training it is imperative to involve the appropriate regional or national level staff persons in the teaching. Possible topics might be decision matrices, nonmarket valuation, and local demand analysis.

Economists in the Forest Service, often working in teams and with a University economist, reported some succesful training sessions for other staffs. Of particular note is the work done with wildlife biologists and range conservationists in economic analysis. More of this could be done. In conducting the silvicultural certification programs, usually done by university faculty, more use of existing Forest Service expertise should be practiced. In training etc. it will often be desirable to have multidisciplinary audiences, for example, an economic analysis workshop conducted simultaneously for silviculturists, wildllfe biologists, and recreation specialists. Such cross training and sharing of ideas can do much to increase cooperative working.

The oft-called "Extension Model" should be widely used in training sessions, shortcourses and other educational sessions for professionals in the Forest Service. This model makes heavy use of case examples to show how similar practitioners have made successful use of various techniques and what problems they encountered. It is usually the particular example or application that remains in a person's mind, rather than the basic theory. Training sessions in economics should also be held for District Rangers, Forest Supervisors, and higher level Washington staff people.

Manuals and handbooks have good and bad points. Sometimes the manual or handbook makes it too easy to not think. One can follow blindly the manual requirements. In addition, while much effort might be put into developing a handbook, it may not be used unless it contains many examples and detailed procedures. However, general guidebooks would seem to be a great help. At the other end of the spectrum is the continued need for readily accessible, user friendly, programs for doing analyses on the Data General or other microcomputers.

The Forest Service spends much money and effort on education and training. However, there may be a need for more lifelong learning opportunities. This is a broad topic and could be the subject of another study. It is merely raised at this point.

Role of the Regional Economist

The position of Regional Economist can be very important. This position should not be tied to any staff area but should be responsible directly to the Regional Forester. Many times the regional economist is in planning or budgeting. This can lead to limitations on the economist's ability to assist where needed. Other staff economists would be needed in specific areas such as timber, recreation etc. but the regional economist must be able to interact with all staffs and to coordinate the work of any other economists in the region (including regions where there are at present only one or two other economists since there might be more in the future).

The Regional Economist should be in regular contact with the Washington Office national economics coordinator. Coordination of economists' work among regions and coordination with the divisions of State and Private Forestry and Research would be facilitated by regular contact.

The Regional Economist should also serve as the primary contact for training or shortcourses in economic analysis for anyone within the region.

In summary, the position of Regional Economist should be very flexible. The person filling the position should have experience at the district or forest level. A graduate level forest economist with undergraduate degree in forestry or related natural resources and a recognized M. S. degree in forestry economics would be the minimal academic qualifications. Some line officers said that the regional economist should have a Ph.D. in forest or resource economics. Furthermore, the Regional Economist should have an ability to teach, and to work effectively with a wide variety of other professionals.

General Management

These general management suggestions tend to be feelings the author developed as the study progressed. They are not necessarily tied into the major objectives of the study and are merely offered here since they might be similar to what others are suggesting.

The use of true public participation could be greatly increased. Ongoing citizen's advisory groups are presently used in some locations but often public participation degenerates to seeking written comment on draft Environmental Impact Statements. Such use of public input is only one small part of true participatory decision making. The benefits to the Agency in decreased appeals and conflict could be major. Often people who are appealing are frustrated with not having their views heard earlier. That

is, they do not necessarily insist that their viewpoint be dominant, but they are frustrated, feeling that no one considered their views.

The Forest Service produces many colorful brochures on certain aspects of the National Forests but could do much more to publicize and market itself. Signing and advertising a timber harvest and wildlife habitat improvement action, or of having tree cover manipulation described in multicolor brochures is possible. More signing and identification of the location of National Forests may be needed in some areas. Campsites, visitor centers, and other recreational areas are well identified but just land or other resource use areas are not so well identified. The public may often not know if it is viewing National Forest or private land and the resulting landscape.

University Responsibilities

Some of the difficulties with economics in the Forest Service must be borne by the Colleges and Universities that educate the many professionals within the Agency. This subsection of the report offers suggestions for improving the teaching of economics and of educating forest and resource economists.

Undergraduate courses in forest or resource economics should stress the basic principles and models of economics and present many different examples of applications. Students tend to learn from examples and listen more attentively when real life examples are presented.

All courses, especially undergraduate ones, should relate economics to other subject matter. For example, applications of economics to intermediate stand mangement decisions for thinning or fertilization should be presented. Applications of economics to "New Perspectives" or ecosystem management must be shown. Major attention should be given to nonmarket resource uses. In all applications students must have actual examples to work through on their own.

Analysis of political situations in economic terms should be included in forest and resource economics course work. Application of the concepts of supply and demand and of elasticity and the incidence and transfer and impact of cost and benefit changes through policy shifts must be studied.

Instead of giving very indepth knowledge of models and techniques in undergraduate courses students should be taught how a particular technique, such as linear programming, can apply basic economic principles and what the model can contribute to managerial decision making.

Students should be required to present and explain various models and techniques in simple terms understandable to laypersons. Communication and presentation in graphical and other ways should be part of the economics courses. It may be all right to leave the teaching of communication skills to specialized courses but their application to presenting economic analyses must be included in an economics course.

Forest and resource economics must be shown to be one of the factors bearing upon decisions. Economics, biophysical sciences, other social sciences and political and legal factors should be integrated. The economics course need not take the time to fully integrate these subjects; that is more properly done in an applied forest or resource management course. However, students should leave the economics course with a clear realization that no one factor is dominant.

In all work there should be as much time spent on sensitivity analysis, probability and risk assessment, as there is on understanding the basic model. That is, students should leave the course realizing that it is in the constant working with a model, or asking the "What if," and "So what" questions that the best use of any technique is to be found.

All the above is not to suggest that the techniques usually covered in typical undergraduate resource economics courses should be changed. Instead, what is suggested is a shift in the way these techniques and models are presented and how students are taught.

Graduate level courses in forest and resource economics should follow the same principles outlined above with greater depth and breadth of coverage of models and techniques. Model development and adaptation to special situations should be included at the graduate level. Also included should be some material in the teaching of economics.

SPECIFIC RECOMMENDATIONS

All problems listed are not of the same order of magnitude and all solutions can probably not be developed and implemented. In this section the author's most important recommendations are given. Hopefully, this

section will provide action items for immediate followup. These recommendations are all considered to be of the same order of priority by the author.

Designate national coordinator for forest economics

This person, located in the Policy Analysis staff, would develop a definite work plan for coordination and leadership in forest economics. The following activities are recommended for the first year:

1. Develop and conduct of a structured meeting for Forest Service economists. Possible topics for the meeting: IMPLAN and other economic impact analysis approaches, nonmarket valuation, decision matrices and weighted summation techniques such as Choosing by Advantage.

2. Form a coordinating committee on economics with economists from National Forest System, State and Private Forestry, Research, other federal agencies especially those within USDA, industry, environmental groups, and universities. This committee would provide guidance for the structured meeting referred to above, develop a statement of the role and use of economics and economists in the Forest Service (this done in concert with Chief and Staff), and study the remainder of the report of this study to develop further action items.

3. Become familiar with the different regions and forests and identify possible major uses of economics in certain areas.

4. Develop tentative staffing plans for increasing the use of economics in problem solving and general management of the National Forests.

Develop production functions

A committee composed of people from different Washington staffs with heavy representation from regional staffs and with good representation of regional or forest level economists would be constituted. This group would assemble existing material about useful production responses, identify major gaps, provide short term "guesstimates" of production functions, and develop long term proposals to develop useful production relationships. This effort would bear heavily on New Perspectives areas of interest.

Economics shortcourses for line officers

The Regional Economist, supplemented by Washington office expertise, particular expertise possibly from other regions, supplemented by Research economists and University personnel would conduct a series of one or two day workshops. These would be aimed directly at District Rangers and Forest Supervisors. Basic principles of economics would be stressed with heavy use of examples relevant to that Region. Following the first workshop the teachers would meet and consult individually with each participant to discuss greater application and use of the concepts presented on the participant's particular area. The second workshop would include presentation and discussion of what was tried, frustrations with the material, and further explanations. It is recommended that a pilot region be selected for an initial trying out of this idea.

Joint teaching/training

A Forest Supervisor and a University faculty forest economist would form a partnership for one College semester. Both would team teach a course in forest economics at the University and conduct a team taught graduate seminar in issues in forest economics related to that Forest. In addition both would be on the Forest together, engaged in joint decision making and management. The logistics might be something like a two week time on the campus with the faculty forest economist taking the lead but with the Forest Supervisor providing real world experience and critique of how analyses were performed and results portrayed. This would be followed by a two week time on the Forest with the Supervisor providing the lead but the economist providing suggestions as to how economic analysis might be done. These two week alternating patterns would be repeated throughout the semester.

OVERALL SYNTHESIS

The Forest Service is a large organization attempting to manage an extremely diverse set of resources, faced with an unbelievable set of public pressures, and with great uncertainty about management outcomes. However, within the Service are hundreds of well meaning and dedicated individuals. The problems and difficulties with economics and with economists have many root causes and not one group or event can be identified. Examination of any of the other disciplines so necessary to intelligent management of the

Nation's resources or analysis of any other federal agency charged with so immense a task would show similar problems and apparent shortcomings.

Increasingly the Forest Service and other federal agencies realize that they cannot be all things to all people. Eventually some choice has to be made; some allocation of scarce resources. Most of the choices will not be global but will hinge on the marginal adjustments that can be made. Like it or not, nonmarket goods and services are and always will be compared to market items. The science and art of economics is involved; even more in the future. It would appear that the key lies in having a set of line officers well versed in economics and a set of enthusiastic, well trained economists well in tune with, and working as full time advisors to, those line officers.

PERSONS INTERVIEWED

Name	Position	Location
REGION 1		
Christopher Risbrudt	Dep. Reg. For.	Missoula
Fred Stewart	Forest economist	Lolo NF
Cindy Swanson	Wildlife economist	Missoula
Orville Daniels	Forest Supervisor	Lolo NF
David Stack	District Ranger	Lolo NF
REGION 2		
Gary Cargill	Regional Forester	Lakewood
Tom Thompson	Dep. Reg. For.	"
John DeVilbiss	Regional economist	"
David Anderson	Director of planning	"
Thomas Ryan	Program budget & RPA	"
William Gee	Ass't dir. timber	"
Dick Lindenmuth	Regional planning	"
James Free	Range management	"
Jeff Starmes	Timber management	"
Thomas Hoots	Forest Supervisor	White River NF
Kevin Riordan	District Ranger	"
Bill Hahnenberg	" "	"
Gerald Hart	Planner	"
REGION 3		
Buddy Stewart	Regional economist	Albuquerque
Alon Carter	Dir. of Budget	"
George Probasco	Planner	Apache-Sit. NF
Carveth Kramer	Planner	Carson NF
REGION 4		
David Iverson	Regional economist	Ogden
John Butt	Dir. Planning	"
Jack McDonald	Program & budget	"
Bob Davis	Planning	"
Betsy Rickards	Oper. Res. & Plan.	"
David Hoefer	Planning	"
James Wes Harvey	S & PF planner	"
Brian Stout	Forest Supervisor	Bridger-Teton NF
William LeVere	Dep. For. Super.	Wasatch-Cache NF

REGION 5

Ronald Stewart	Regional Forester	San Francisco
Michael Rogers	Act. Dep. Reg. For.	"
Michael Skinner	Regional economist	"
Lynn Delain	Appeals & economics	"
Richard Duperon	Budgeting	"
Eric Smith	Timber budget. TSPIRS	"
Robert Erwin	S&PF	"
Gary Plisko	Recreation	"
Klaus Barber	Systems analysis	"
Charles Garrison	Engineering	"
Joyce Cooper	"	"
John Grosvenor	"	"
Val Russell	"	"
John Kruse	Planner	Shasta-Trin. NF
David Smith	Forest economist	"
Christy Hern	Recreation	"
Irl Everest	District Ranger	"

REGION 6

John Butruille	Regional Forester	Portland
Richard Phillips	Regional economist	"
Sarah Crim	Timber economist	"
Marc Wiitala	Economist S&PF	"
James Merzenich	Planning analyst	"
Tom Nygren	Dir. Planning	"
Sharon Heywood	Ass't Dir. Plan.	"
Chris Hansen	Forest economist	Mt.Baker-Sno NF
Bill Connelly	Forest economist	Umpqua NF
Joyce Ulbrich	Forest economist	Mt. Hood NF
Dennis Holthus	District Ranger	Siskiyou NF
Mark Cooper	Forest economist	"
John Peters	Timber & silvi.	"

REGION 8

Marvin Meier	Dep. Reg. For.	Atlanta
Richard Greenhalgh	Economist	"
Clair Redmond	Economist	"
Bennett Foster	Economist	"
Richard Ullrich	Plan. & Budget	"
Karl Stoneking	Timber plans	"
Jimmy Walker	Timber management	"
Lee Ehmer	S&PF soil & water	"
George Dissmeyer	Hydrolgist	"

REGION 9

James Jordan	Dep. Reg. For.	Milwaukee
Paul Monson	Regional economist	"
William Shirley	Planner	"
Douglas Ilhardt	Timber plan.TSPIRS	"
John Hazel	Timber managment	"
John Ramquist	Analyst	Superior NF
John Vrablec	Planning	Chequamegon NF
Donald Howlett	Planning	"

EXPERIMENT STATIONS

Richard Haynes	Econ. Proj.Ldr.	Portland
George Peterson	Econ. Proj. Ldr.	Ft. Collins
Ervin Schuster	Econ. Proj. Ldr.	Missoula
J. Greg Jones	Economist	"
Mike Niccolucci	Economist	"
Mary Meacham	Programmer	"

WASHINGTON OFFICE

John Combes	Economist, timber
David Darr	Branch Chief Econ. Research
Edward Frandsen	Economist, range
Richard Guldin	Budget coord. research
Adrian Haught	Branch Chief RPA analysis
Anne Huebner	Economist, research
Linda Langner	Economist, RPA
Bob Randall	Economist, wildlife
Dennis Schweitzer	Economist, land mgmt. plan.
Greg Super	Economist, recreation

Decision Matrices and Weighting Summation Valuation in Forest Land Planning

Hugh O. Canham, *SUNY College of Environmental Science and Forestry, Syracuse, NY 13210.*

ABSTRACT. Decision matrices offer a useful way of displaying the effects of alternative plans for an area of forest, or other land. When combined with the weighting summation method of valuation, analysts and decision-makers can compare alternative plans more objectively than with many other techniques. The method is explained with the use of a hypothetical example.

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A decision matrix in its simplest form is merely a way of showing the differences and similarities among alternatives. One of its uses is to bring together and summarize the effects of different plans on a set of decision criteria. Decision matrices appear to be useful in forest land planning, especially when combined with the weighting summation method of valuation. When run on an electronic spreadsheet, the technique allows the forest planner to easily and rapidly evaluate different land management plans given different values, or viewpoints of different interest groups.

This article describes the technique of using decision matrices in conjunction with the weighting summation method of comparative valuation. The procedures are discussed by using a hypothetical example. Several real world examples of using these techniques exist but they generally are not in published form. The USDA Forest Service is urging the use of decision matrices in analyzing land planning alternatives. Environmental impact analysis will often contain a decision matrix. The weighting summation method of comparative valuation has been used for comparing alternative sites for a manufacturing plant, solid waste disposal, or alternative power line locations (see, for example, Hobbs 1978, Leopold 1969, Zieman et al. 1971).

Forest land planning often involves different kinds of goods and services (outputs) on the same compartment, planning unit, or forest. Some of these outputs, such as timber, can be measured in conventional volume terms and valued at market prices. Recreation is often measured in recreation visitor days or in wildlife and fish-user days. Through various nonmarket techniques recreation can be valued in monetary terms. Other forest management outputs such as change in visual character of the landscape, amount of soil erosion, or jobs created in the local economy all can be measured in some terms, and conceptually could be evaluated in monetary terms. However, it is often beyond the ability or resources of the forest planner to measure all outputs in numerical terms and perhaps harder to convert the quantity measure to monetary value terms. Yet in spite of this limitation the different forest outputs must be compared, even if uncertain and subjective. Some decision must be reached as to the best alternative plan. Conversion of values to monetary terms will not be discussed in this article. Several excellent texts and numerous articles on the subject exist (Sinden and Worrell 1979, Walsh 1986). Instead, the weighting summation method of comparison is discussed. This method offers a way of expressing values in relative importance, or utility numbers. The weights, or value numbers, serve the same purpose as monetary values; they can be used for comparing different commodities.

PROCEDURE

Table 1 shows a decision matrix for a hypothetical forest compartment. In this example the forest outputs, or decision criteria as they will be called hereafter, are shown in the left-hand column. They are timber quantity (MBF) and the present net worth (PNW) of future harvests, road density in miles of road per square mile of forest land, recreation visitor days both for developed areas (DEVELOPED) and for dispersed or backcountry uses (BACKCOUNTRY), new jobs created in the local economy (JOBS), acres of improved wildlife habitat created, and visual quality of the compartment. Other criteria could be chosen, but for this example these have been chosen as important for deciding on a plan of action. Development of actual criteria would come from issues, concerns, and opportunities identified in other planning processes, public involvement, company goals, and constraining policies. The criteria represent the items of value (costs as negative values, benefits as positive values) that are important in the decision-making process.

Arranged in a series of columns across Table 1 are the estimated amounts (magnitude) that each plan (A, B, C, D) will produce for each criteria. For this example, four alternative plans have been developed. The development of actual, meaningful alternatives is another task accomplished in earlier planning. Just achieving this step can be monumental, yet displaying the estimated magnitudes in a succinct tabular format is extremely helpful to decision-making.

From Table 1 an observer can see what is happening under each alternative. Accompanying text in a report would explain and elaborate on the summary information in such a table. For example, in this hypothetical example visual quality of the four plans is rated on a simple scale from 1 to 10, or low to high. Recreation visitor days are based on estimated availability of camping areas and amount and quality of backcountry areas. Timber volume to be harvested is derived from a growth and yield simulator, and present net worth of the timber is based on an economic analysis with specified discount rates, planning horizons, and stumpage prices.

A choice can be made, at this point, between the alternative plans by using an implicit set of values to compare the magnitudes of each decision criteria among all plans. Such "professional judgment" is valuable and is what the forester is supposedly trained to do. However, it is often more useful to state explicitly the weights, or values, given to each of the decision criteria. That is, state the explicit relative importance of physical timber yield to recreation visitor days or to road density. This explicit statement enables others (for instance the public) to see the basis on which a de-

Table 1. Decision matrix with unscaled magnitudes.

Criteria	Plans and magnitudes			
	A	B	C	D
Timber				
MBF	30	60	30	20
PNW	678	900	300	300
Road density	3	6	8	1
Recreation				
DEVELOPED	150	100	50	0
BACKCOUNTRY	100	50	300	300
JOBS	10	10	15	5
Wildlife habitat	200	100	300	100
Visual quality	10	2	9	5

cision was reached. If the explicit weights are revealed, they can be changed to reflect different viewpoints.

Developing a set of numerical weights to reflect the importance, or value, of each decision criterion is not easy. A perfectly functioning market captures the values of interested parties, and would measure values of all decision criteria. However, markets are not usually perfect, hence some nonmarket valuation technique is needed. Derivation of accurate utility or value weights has long been the subject of theoretical and applied research. Different weight scales can be used. A common one is to assign each decision criteria a numerical value from −10 to +10 reflecting its relative value, possibly recognizing both short-term and long-term values (as in Zieman et al. 1971). Other techniques include allocating 100 points among the criteria reflecting the relative values. Whatever technique is used the weights should reflect the relative value, or importance, of each criterion to all others in the matrix. In the hypothetical example in this paper, we assigned each criterion a weight from +20 to −20 reflecting its value relative to the other criteria in the table. As indicated above, many different scales can be used for the weights. The range of plus 20 to minus 20 was comfortable for use in this example.

Weights must reflect the importance or value of criteria; they should mirror values of affected parties. For the nonindustrial forest owner's land these should be the owner's values. For private corporations the affected parties include stockholders, managers, and possibly others. For public ownerships the weighting must reflect the public interest, a formidable task. Citizens groups, advisory committees, expert judgment: these and other techniques of public participation can be used to develop a set of numerical weights.

Various public participation and group dynamics techniques exist for developing consensus on a set of weights. Simple procedures are to have each member of a selected group assign weights to each criterion then average the group results. Alternatively, the decision-maker can form a judgment as to the average weights probably held by the relevant people. More sophisticated techniques include the Delphi technique as described by various authors and the Nominal Group technique. In both of these techniques, several rounds of weight-assigning, discussion, and opportunity for individual revision of weights takes place.

After assigning weights the planner might be tempted to multiply weights by the numerical magnitudes and add the sums. This would be possible except for the widely varying scales on which each criterion is measured. In the example, timber volume is measured in thousands of board feet and ranges from to 300 to 900, while road density, measured in miles of road per square mile of forest, ranges from 1 to 8. Without some scaling technique, simple addition of magnitudes is meaningless.

The purpose of scaling is to place different data sets on the same relative basis. Several different techniques are possible. The scaling technique recommended for use in decision matrices is the same one used in regression analysis, namely, construction of "Z scores". Each data point in a set is expressed as another number reflecting the relationship of the original number to both the mean and standard deviation (scatter) of the data set. The formula for calculating the Z score is:

$$Z = (x_i - x_m)/S_x$$

where

x_i = data point,
x_m = average of all points in data set, and
S_x = standard deviation of the data set.

Table 2 shows the Z scores for unscaled magnitudes in Table 1. Also included in this table are the average and standard deviation of the data for each criterion. Note that now each number in a row expresses the relationship of that individual magnitude to the average, either above (+) or below (−), and how far it is from the average as a percent of the standard deviation. All different data are now on a common scale and can be combined.

After scaling, the question is often asked "Why not just add the scaled magnitudes together instead of worrying over weights?" If scaled magnitudes are added together, the analyst is automatically assigning a weight of one to each decision criteria.

Table 3 shows the results of applying the weighting summation procedure to the hypothetical example. Three different sets of weights have been used. Weight set #1 assigns equal weights to each criterion, weight set #2 values timber heavily and recreation and visual quality moderately. Weight set #3 favors backcountry recreation, visual quality, and wildlife habitat and assigns a greater negative impact to roads. At the bottom of the table are the summed weighted values, or scores, of each plan. These represent the multiplication of the scaled magnitude of a criterion by its weight and summing over all criteria in an alternative. For example, with the first set of weights plan A has a score of 2.71, plan B scores −0.58, plan C scores 1.66, and plan D scores −3.79. The decision rule to apply is to choose the alternative with the highest score. Thus, using weight set #1 plan A would be chosen. The scores are meaningful only within a weight set. Scores for a given set of weights cannot be compared to scores obtained with other weights. Thus the scores using weight set #2 are quite different in size from those using weight set #1. However, the same decision rule applies, namely, choose the alternative with the highest score. In this case plan A still ranks first, but now plan B ranks second and plan C, which ranked second with the first set of weights, drops to third. Plan D is still ranked fourth. Finally, using weight set #3, plan C ranks first and plan A is second, D is third, and B is fourth.

DISCUSSION

The difference in ranking among the alternatives with different sets of weights is to be expected. Indeed, this is what happens, even without explicit weights, when different people, with different goals and value sets compare alternatives. The compact, explicit, numerical makeup of the decision matrix facilitates sensitivity analysis and examination of what causes these differences. Furthermore, conflicting parties can focus on precisely what is bothersome. What is

Table 2. Decision matrix with scaled magnitudes.

Criteria	Scaled magnitudes A	B	C	D	Average unscaled magnitude	standard deviation
Timber						
MBF	−0.33	1.67	−0.33	−1.00	35.00	15.00
PNW	0.52	1.38	−0.95	−0.95	544.50	256.79
Road density	−0.56	0.56	1.30	−1.30	4.50	2.69
Recreation						
DEVELOPED	1.34	0.45	−0.45	−1.34	75.00	55.90
BACKCOUNTRY	−0.77	−1.21	0.99	0.99	187.50	113.88
JOBS	0.00	0.00	1.41	−1.41	10.00	3.54
Wildlife habitat	0.30	−0.90	1.51	−0.90	175.00	82.92
Visual quality	1.09	−1.41	0.78	−0.47	6.50	3.20

Table 3. Decision matrix with weights and scores.

Criteria	Weights Set #1	Weights × scaled magnitudes A	B	C	D	Weights Set #2	Weights × scaled magnitudes A	B	C	D	Weights Set #3	Weights × scaled magnitudes A	B	C	D
Timber	1.00					20.00					2.00				
MBF	1.00	−0.33	1.67	−0.33	−1.00	5.00	−1.67	8.33	−1.67	−5.00	1.00	−0.33	1.67	−0.33	−1.00
PNW	1.00	0.52	1.38	−0.95	−0.95	15.00	7.80	20.77	−14.28	−14.28	1.00	0.52	1.38	−0.95	−0.95
Road density	−1.00	0.56	0.56	−1.30	1.30	−5.00	2.79	−2.79	−6.50	6.50	−10.00	5.57	−5.57	−13.00	13.00
Recreation	1.00					10.00					10.00				
DEVELOPED	1.00	1.34	0.45	−0.45	−1.34	6.00	8.05	2.68	−2.68	−8.05	2.00	2.68	0.89	−0.89	−2.68
BACKCOUNTRY	1.00	−0.77	−1.21	0.99	0.99	4.00	−3.07	−4.83	3.95	3.95	8.00	−6.15	−9.66	7.90	7.90
JOBS	1.00	0.00	0.00	1.41	−1.41	3.00	0.00	0.00	4.24	−4.24	5.00	0.00	0.00	7.07	−7.07
Wildlife habitat	1.00	0.30	−0.90	1.51	−0.90	7.00	2.11	−6.33	10.55	−6.33	9.00	2.71	−8.14	13.57	−8.14
Visual quality	1.00	1.09	−1.41	0.78	−0.47	10.00	10.93	−14.06	7.81	−4.69	10.00	10.93	−14.06	7.81	−4.69
Sum(wts × mag) Set #1	2.71	−0.58	1.66	−3.79											
Rank	1	3	2	4											
Sum(wts × mag) Set #2	26.94	3.78	1.42	−32.14											
Rank	1	2	3	4											
Sum(wts × mag) Set #3	15.94	−33.48	21.17	−3.63											
Rank	2	4	1	3											

needed to bring agreement can be seen.

SUMMARY

This article has described the use of decision matrices and the weighting summation method as it might be applied to forest land planning. Many of the finer points underlying the assumptions and many of the associated techniques needed to effectively use the technique cannot be covered in one article. Instead the purpose was to describe the overall technique and show how to use it. Foresters and other resource planners are urged to use the technique. It is recommended that they seek additional guidance from resource economists or others familiar with valuation and numerical ranking techniques.

The method does not excuse sloppy data gathering or use of unfounded information. However, if comparison of alternatives and different weight sets shows some alternative plans to be consistently ranked low, then those alternatives can be dropped. Or, if sensitivity analysis shows that rankings remain the same even with wide variation in the magnitudes of some criteria, those criteria need not receive more attention in any further refinement of the basic data. Sensitivity analysis means altering various bits of data, raw magnitudes, or weights to see the differences in final scores. Such alteration of data should not be whimsical but should be based on known or suspected confidence intervals, errors, or other variation in the reported numbers.

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Break-Even Benefit/Cost Model: a Useful Tool for Forestry Decision-Making

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ABSTRACT. Comparing benefits to costs is basic to decision-making. However, in forestry activities, particularly those involving multiple use, evaluating benefits is difficult. The break-even benefit/cost model eases the problem somewhat: it calculates the minimum benefit required for the project to just break even on a discounted basis. Examples are shown for pest control and soil erosion control.

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Many situations in forestry are difficult to analyze using traditional economic models: there are long time periods to contend with, benefits are not easily measured in monetary terms, and there is often much uncertainty about the amount of benefit or loss that might result from any given action. However, most foresters would agree that in management planning, the expected benefits of a possible action should be compared to the expected costs. In many cases, the decision-maker has some general idea about the level of benefits and if asked could state whether or not they would exceed some threshhold level. The break-even benefit/cost (BEBC) model can be used to determine this threshhold value and is well suited to multiple time periods and uncertainties.

The break-even benefit/cost model has been applied by Porterfield and Ledig (1981) to evaluate tree improvement programs. Carrigan (1983), in comparing several models for economic evaluation of tree improvement programs in New York, concluded that the BEBC model was the best one to use.

THE MODEL

In the conventional benefit/cost ratio model the amounts of revenues (benefits) and costs that occur at different times in the future are determined, these future benefits and costs are discounted to the present using an appropriate interest rate, and the discounted, or present, value of the benefits (PVB) is compared to the present value of the costs (PVC). Other things being equal, an activity is considered worthwhile if:

$$PVB/PVC >= 1$$

Stated in other words, a project with a benefit/cost ratio of more than 1 is profitable, a project with a ratio of 1 is just breaking even, given the interest rate and expected future stream of benefits and costs. Several texts describe this (Duerr 1984, Gregory 1972, McGuigan and Moyer 1983, Sassone and Schaffer 1978).

The break-even benefit/cost model is applied when benefits are unknown, whereas costs can be forecast with some degree of certainty. The analyst proceeds by first determining

the level and timing of costs. This cost stream is then discounted to the present at an appropriate interest rate (discussed below). The decision-maker can then be asked whether or not the present value of all future benefits could be expected to exceed this level. However, most people do not readily think in terms of a sum of present or discounted future values. Therefore the calculated present value of the costs is usually converted to its equal annual equivalent. The decision-maker can now relate this to other, more easily understood amounts.

The formula for discounting a single future amount to the present is:

$$V_o = V_n/(1 + i)^n$$

where

V_o = present value,
V_n = future amount,
n = number of years until future amount occurs, and
i = interest rate.

This formula can be used for calculating the present value of a repeating series of periodic or annual costs by reapplying the formula each period or year. Many computer routines are available for determining present values utilizing this approach. For hand calculations various other formulations have been developed from this basic one. See, for example, Clutter et al. (1983) or Davis (1966).

The formula for converting the present value into an equal annual amount for a finite time period is:

$$A = V_o[i(1 + i)^n]/[(1 + i)^n - 1]$$

where

A = annual equivalent value,
V_o = present value,
n = number of years annual amount remains in effect, and
i = interest rate.

For an infinite time period, i.e. n = infinity, the formula becomes:

$$A = V_o \times i$$

where the symbols are as defined above.

The calculated annual equivalent amount is the break-even amount of benefit. It is also the opportunity cost of performing the activity. This opportunity cost can be highlighted in analyses or used to determine the threshhold value of the benefits. It represents the annual equivalent amount of those resources given up, and valued in money (inputs, costs), which could be devoted to another project.

A major effort in any investment analysis is determining the discount (interest) rate to use. The appropriate one is the firm's alternative or guiding rate of return (Duerr 1984). This is the rate that the decision-making entity could either (1) receive at the next best investment alternative, or (2) borrow funds to undertake any activities. Care must be taken to distinguish between the stated, or nominal, rate and the actual, or real, interest rate. Available interest rates, nominal rates, as quoted by banks etc., include allowances for risk and inflation. In contrast, the real rate is the return on an investment after subtracting changes in monetary value due to inflation and after deleting any allowances for risk. The USDA Forest Service advocates a 4% real rate in land management planning but recognizes other rates as appropriate. If a single rate cannot be determined, a range of interest rates can be used in the analysis to check the sensitivity of the break-even point of the project to different rates.

EXAMPLES OF APPLICATION

Two hypothetical examples are used to show how the model might be applied: insect control and soil erosion control.

Suppose a forester wishes to know if a contemplated gypsy moth control program will yield returns at least equal to its costs. The 20-year management regime and the present value of the costs and revenues, using discount rates of 4, 8, and 10%, are shown in Table 1. At 4% the sum of all discounted values is $333.21. This amount expressed as an equal annual equivalent for the next 20 years is $24.52 per year. Alternatively, if the manager feels that the treatment will result in continuous benefits forever, an infinite planning horizon, the annual equivalent (at 4% interest) becomes $13.33. The resource manager must now ask if it is reasonable to expect at least this level of increase in the present value of timber values from the proposed control program. For 4, 8, and 10%, annual break-even amounts for the 20-year time period vary from $24.52 to $33.00.

The soil erosion control example assumes a 100-acre northern hardwood sawtimber forest for which a shelterwood cut has been planned to begin immediately. The stand contains 8 MBF per acre, 50% of which will be removed now and 50% in 15 years (growth is ignored to simplify). Average stumpage price is $60 per MBF (for simplicity, constant for the next 15 years). An uncut 2-chain strip will be left along 30 chains of streambank (6 acres not cut) and water bars and grading of skid and haul roads will be done at an added cost of $500. At the beginning of the removal cut in 15 years an additional $200 of road rehabilitation will be done (Table 2). Timber revenue foregone, the opportunity cost of not cutting the strip along the stream, is $1440 for the first cut and, at the 4% discount rate, $799.58 for the second cut. Similarly the present value of added road costs is $500 for the initial roads and $111.05 for the future rehabilitation. Total present value of all costs is $2850.63, or on an annual basis $256.39 for the next 15 years and $114.02 for an infinite time period.

The benefits from these activities are postulated as decreased stream siltation, maintenance of more favorable stream temperatures, and more fish. Are these benefits greater than the cost? Many techniques have been developed for valuing nonmarket benefits such as these [see for example Sinden and Worrell (1979), or Hufschmidt et al. (1983)]. One of these techniques may be needed to determine monetary benefits. However, the question could be asked: Is it reasonable to assume that the annual benefits could be at least equal to $114.02 per acre (lower value) or $306.68 per acre (upper value)?

Alternatively, the percent of total revenue foregone can be examined. Without the treatments the financial yield from the entire 100 acres will be $24,000 (for the first cut) plus $13,326.35 (present value at 4% of the second cut in 15 years) for a total present value of $37,326.35. The revenue given up plus the added roading costs (at 4%) have a present value of $2850.63. This is 7.6% of the without-treatment revenue. The question to be

Table 1. Cost analysis of hypothetical gypsy moth control program at different interest rates.

Activity	Cost (−) or revenue/ac	Year	Present value at 4%	Present value at 8%	Present value at 10%
Spray	−$100	1	−96.15	−92.59	−90.91
Spray	−$100	2	−92.46	−85.73	−82.64
Spray	−$100	3	−88.90	−79.38	−75.13
Noncommercial thinning	−$40	5	−32.88	−27.22	−24.84
Commercial thinning	$50	20	+22.82	+10.73	+7.43
Spray	−$100	20	−45.64	−21.45	−14.86
Total present value			−$333.21	−$295.64	−$280.95
Annual equivalent (20 years)			24.52	30.11	33.00
Annual equivalent (infinity)			13.33	23.65	28.10

Table 2.- Cost analysis of hypothetical soil erosion control program at different interest rates.

Activity	Cost (−)	Year	Present value at 4%	8%	10%
Timber revenue foregone	−$1440	0	−1440.00	−1440.00	−1440.00
Timber revenue foregone	−$1440	15	−799.58	−453.95	−344.72
Added road cost, etc.	−$500	0	−500.00	−500.00	−500.00
Added road cost, etc.	−$200	15	−111.05	−63.05	−47.88
Total present value			−2850.63	−2457.00	−2332.60
Annual equivalent (15 years)			256.39	287.05	306.68
Annual equivalent (infinity)			114.02	196.56	233.26

answered by the decision-maker is: Are you willing to forego about 8% of the revenues to enhance the non-market benefits described above?

APPLICATION AND LIMITATIONS

Any decision-making model is a tool to be applied carefully. The BEBC model merely presents a simplified way of considering some benefits that are hard to evaluate. The educated judgements of decision-makers and other parties with interests in the decision are still required. Should that judgemental ability not be available then other models utilizing more advanced techniques may be needed. However, the technique described here can assist in many situations where a threshhold value estimate may suffice. □

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